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Device for the Continuous Casting of Metal

The invention relates to a device for the continuous casting of metal, in particular, steel, comprising a lifting platform which can be driven by means of a drive device so as to oscillate, further comprising a continuous casting mold received on the lifting platform, as well as a stationary support frame which is provided with guiding or bearing elements for the lifting platform.

It is known to subject a casting mold to an oscillating movement in order to assist a continuous casting process during continuous casting. Conventionally, continuous casting molds are received on lifting platforms which transmit this oscillating movement onto the mold while they themselves are provided with drive means. This lifting platform is received on a base frame or support frame and is supported therein by means of roller bearings or slide bearings.

As a substitute for roller bearings and slide bearings spring systems are known, for example, from EP 0 150 357 B1. A guide device is described herein for a continuous casting mold wherein holders are fastened on a unitary mold lifting platform, wherein each holder is connected by means of a spring element with a changing frame positioned on the base frame. These holders are comprised of a spring support which receives a straight leaf spring on which an intermediate piece, connected to the mold lifting platform, is centrally positioned.

It is an object of the invention to provide a device for the continuous casting of metal, in particular, steel, with guide

elements between the lifting platform and a stationarily arranged support frame, which guide elements are simple, wear-resistant, and maintenance-free and ensure a precise guiding of the lifting platform independent of thermal expansions.

This object is solved with the devices having the features of claim 1 and claim 2. Advantageous embodiments are disclosed in the dependent claims.

The gist of the invention resides in the embodiment of the guide element as a load balancing system which, in addition to receiving the load in the oscillation direction, also receive the loads in the directions perpendicular thereto. A first load balancing system is formed as an elastic spring system. It is comprised of two spring legs, arranged angularly relative to one another, preferably at an angle of 90°, which extend perpendicularly to the oscillation direction, respectively, wherein the two spring legs are formed like a tuning fork and wherein the overlapping upper and lower ends of the two spring legs, respectively, form the support surface for the lifting platform or the connecting surface with the stationarily arranged support frame and wherein the spring system receives forces in both directions perpendicular to the oscillation direction, in addition to the force in the oscillation direction. A second conceivable load balancing system is suggested in the form of a pressure-controlled cushion system which is operated with a corresponding medium, preferably air or a corresponding liquid.

Overall, in contrast to the known roller bearings and slide bearings, a maintenance-free support action of the oscillating lifting platform on a support frame is ensured, in particular, by means of the spring system. The guide action is without play

because, aside from the elastic deformation of the springs, no change of the movement geometry takes place.

According to a first embodiment, the two tuning fork-shaped legs of the spring system are a unitary part and, according to a second embodiment, they are of a two-part configuration. A first outer part is connected with the lifting platform, a second outer part with the support frame. The spring system can be adjusted by movement of the two lower leg parts. By means of different dimensions of the leaf springs which form the tuning fork with respect to their length, width, and thickness, the spring action and the movement precision can moreover be adjusted to various applications.

Further details and advantages of the invention result from the claims and the following description. In this connection it is shown in:

Fig. 1 a schematic side view of the continuous casting device with lifting platform and support frame;

Fig. 2 a schematic side view of the continuous casting device with lifting platform and support frame with guide columns;

Fig. 3 a front view of the continuous casting device with mold, lifting platform, and support frame;

Fig. 4 a plan view of the continuous casting device;

Fig. 5 a side view of a unitary spring system;

Fig. 6 a plan view onto the spring system of Fig. 5;

Fig. 7 a side view of a two-part spring system;

Fig. 8 a plan view onto the spring system according to Fig. 7;

Fig. 9 a first embodiment of a two-part spring leg configuration of a spring system;

Fig. 10 a second embodiment of a two-part spring leg configuration of a spring system.

The continuous casting device 1 according to Fig. 1 is comprised of a two-part support frame 2a, 2b with a two-part lifting platform 3a, 3b, wherein the lifting platform receives the casting mold (not shown), for example, a mold for casting thin slab. As a result of the side view being shown, only the support frame element 2a and the lifting platform element 3a are visible. A lifting platform element has an L-shaped basic form (see Fig. 3) and is comprised of two parts 31a, 32a symmetrical to the longitudinal axis. The lifting platform element 3a is supported on a stationary support frame element 2a. It receives a lifting cylinder 4a whose plunger 5a is anchored in the foot area 33a of the lifting table 3a. The lifting platform element 3a and thus the mold are subjected to an oscillating movement.

By means of guide elements in the form of a spring systems 61a, 62a, 63a, 64a the lifting platform element 3a is supported on corresponding parts of the support frame 2a. In the foot area of the lifting platform element 33a two cubes 71a, 72a are fastened which provide the connection between the lifting platform element and the spring systems 61a, 62a. On the other side, spring systems

63a, 64a are also connected to the support frame 2. For this purpose, the head area of the lifting platform element is provided with two projections 81a, 82a which rest on the spring systems 64a, 63a. The spring systems 64a, 63a are supported on parts of the support frame 2a whose configuration is not illustrated in detail in this connection.

The individual spring systems 61a to 64a are each comprised of two spring legs which are arranged at a right angle to one another. In the viewing direction of the side view, the spring leg is therefore illustrated only as a point. A spring leg, respectively, is shaped corresponding to the basic form of a tuning fork. For describing the spring system, reference is being had to the detail illustrations of Figs. 5-10.

Fig. 2 shows in a side view the guide and support columns 91a, 92a, not illustrated in Fig. 1, whose surfaces 101a, 102a at the head end are provided for a balancing support of the two projections 81a, 82a of the lifting platform element by means of the spring systems 64a, 63a. The configuration height of the guide columns 91a, 92a is determined by the height of the lifting cylinder 4a and by the height of the mold, respectively. Reference numerals 111a, 112a identify supply inlets for the cooling water of the mold.

Fig. 3 illustrates a side view of the continuous casting device which is rotated by 90° relative to the side views of Figs. 1 and 2. The two support frame elements 2a, 2b receive each a cylinder 4a, 4b. First and second L-shaped lifting platform elements 3a, 3b are arranged opposite one another and at a spacing to one another and receive on corresponding support surfaces 122a, 122b the mold 13 with the casting width Y. Underneath the exit of the mold, the first segments 142a, 142b are illustrated, i.e., the first rollers

for guiding the strand with solidified shell after exiting from the mold. The two lifting platform elements 3a, 3b are supported and guided in an oscillating way by means of the spring systems 62a, 63a, 62b, 63b on or at the support frame elements 2a, 2b, wherein the upper part of the support frame element is not illustrated.

Each lifting platform element 3a, 3b is supported and guided by a total of four spring systems, wherein the upper ones (63a, 64a, 63b, 64b) are arranged staggered relative to the lower spring systems (61a, 62a, 61b, 62b). Overall, this results in an optimally balanced bearing and guiding system. It is not only possible to receive forces in the oscillation direction but also in the directions perpendicular thereto. A movement of one spring system is compensated immediately by the three other spring systems in the same horizontal plane or by the spring system which are arranged vertically staggered thereto. After experiencing an external force action, the total system will therefore always oscillate back automatically into the initial position.

The plan view according to Fig. 4 illustrates the staggered arrangement of the individual spring systems 61a, 62a relative to 63a, 64a as well as 61b to 64b on the opposite side for supporting a lifting platform element. The respective lifting platform element 3a, 3b is supported and guided by the support frame 2a, 2b as well as the guide columns 91a, 92a and 91b, 92b of the support frame. The support surfaces of the mold on the lifting platform are identified with the letter A. The respective lifting cylinder 4a, 4b extends centrally relative to the lifting platform element. Laterally thereto, the supply inlets 11a, 112a, 111b, 112b for the cooling medium for cooling the wide side of the mold are provided.

If needed, the number of guide elements in the form of spring systems can be increased for an optimal load balancing action. The arrangement of two additional spring systems for each lifting platform element is identified by the letter X.

Figs. 5 and 6 show a side view as well as a plan view of a monolithic spring systems in detail. A spring system is comprised of two spring legs 201 and 202 which are arranged at a right angle to one another. In this embodiment, one spring leg 201, 202, respectively, is formed by a unitary U-shaped leaf spring which thus forms an upper part 201a, 202a and a lower part 201b, 202b. While the width B of the leaf spring has a smaller effect on the properties of the entire system, the length L and the thickness D of the individual leaf spring or the tine of the formed tuning fork have a greater influence on the properties of the total spring system. When using a casting mold for thin slab, the following dimensions are recommended for the spring system: width B = 100 mm; length L more than 200 mm; thickness D approximately 12 for 14 mm. The spacing between the upper and the lower spring parts 201a, 201b in the unloaded state is 20 mm ± 5 mm. The spring material is preferably stainless spring steel.

The end pieces 211a, 211b, 212a of the upper or lower part of the spring leg, which in this embodiment are monolithic, serve as support surfaces for the respective lifting platform element or connecting surface with the support frame.

A bore 213 is introduced into the end pieces of the spring legs for receiving a screw connection with countersunk screw head which ensures a detachable connection of the spring system with the lifting platform side. The lower ends of the spring legs (201b, 202b (not shown)) are changeable with respect to their position and

adjustable. For this purpose, a bore 214 is provided within the end pieces 211b, 212b (not shown) of these parts. The adjustment is realized by a mutual effect of the screw bolts. The arrows shown in Fig. 6 illustrate that the disturbing forces K occurring perpendicularly to the oscillation direction can be compensated by the suggested spring system.

In comparison to this, Figs. 7 and 8 show the side view and plan view of the two-part embodiment of the spring system. The end pieces of the two spring legs are connected by a screw connection to one another. The first spring leg 301 (not completely illustrated here) is comprised of an upper and lower part 301a, 301b. At a right angle to this leg 301 the two parts 302a, 302b of the second spring leg 302 are arranged. By means of the screw connection 303 which extends to the bottom of the part 301a, the end pieces of the spring legs are connected to one another. In an analog fashion, the lower parts of the two spring legs 301b and 302b are connected with one another by a screw connection 304. In addition, a slide 305 between the parts 301b and 302b is provided whose one side surface 305a can be screwed down by an additional screw connection 306 against the end piece of the lower part 301b. Overall, the lower part of the spring system is thus adjustable in the direction illustrated by the arrow.

The plan view of Fig. 8 illustrates that at the lower area of the spring system an adjustment of the spring system in two directions, indicated by the arrows, is possible by means of the two adjusting screws 306 and 307. The two parts of the intermediate slide 30a, 305b rest by means of fitting sheet metal panels 306a, 306b on the corresponding end pieces. Overall, with this embodiment with the above mentioned concrete dimensions of a length of 200 to 220 mm and a thickness of 12 or 14 mm, a stroke of ± 5 mm can be

compensated. The adjusting stroke on the adjusting side is also ± 5 mm.

Fig. 9 shows an embodiment of the spring leg of a spring system wherein the spring leg is not a bent spring but is comprised of two spring elements. The two spring elements 401 and 402 are spaced apart from one another by means of spacer members 403a, 403b and are detachably connected to one another by a screw connection 404. According to a second embodiment (Fig. 10) the spacer members can be eliminated in that already the upper spring element 501 is formed as a unitary part with a corresponding bridge element 503. A detachable connection is again realized by means of a screw connection.